M.Sc. BIOTECHNOLOGY
(CBCS Semester)
Scheme of Teaching and Examination

I Semester

Paper code and title	Teaching Hr./wk.	Exam. Hr.	Marks			Credit
			Exam.	IA*	Total	
Theory						
BT 401: Biochemistry and Biophysics	04	03	70	30	100	04
BT 402: Microbiology	04	03	70	30	100	04
BT 403: Cell Biology	04	03	70	30	100	04
BT 404: Molecular Genetics	04	03	70	30	100	04
Practical						
BT 405: Biochemistry and Microbiology	08	04	70	30	100	04
BT 406: Cell Biology and Molecular Genetics	08	04	70	30	100	04
Seminar/Mini Project	01			25	25	01
Total			**420**	**205**	**625**	**25**

II Semester

Theory						
BT 451: Molecular Biology	04	03	70	30	100	04
BT 452: Genetic Engineering	04	03	70	30	100	04
BT 453: Enzymology	04	03	70	30	100	04
BT 454: Bioprocess Technology	04	03	70	30	100	04
Practical						
BT 455: Molecular Biology and Genetic Engineering	08	04	70	30	100	04
BT 456: Enzymology and Bioprocess Technology	08	04	70	30	100	04
Seminar/Mini Project	01			25	25	01
Total			**420**	**205**	**625**	**25**

III Semester

Paper code and title	Teaching Hr./wk.	Exam. Hr.	Marks			Credit
			Exam.	IA*	Total	
Theory (501 Choice-based paper)						
BT 501: Principles of Biotechnology	04	03	70	30	100	04
BT 502: Microbial Biotechnology	04	03	70	30	100	04
BT 503: Animal Biotechnology	04	03	70	30	100	04
BT 504: Plant Biotechnology	04	03	70	30	100	04
Practical						
BT 505: Microbial Biotechnology and Metabolism	08	04	70	30	100	04
BT 506: Animal and Plant Biotechnology	08	04	70	30	100	04
Seminar/Mini Project	01			25	25	01
Total			**420**	**205**	**625**	**25**

IV Semester

Theory						
BT 551: Immunology	04	03	70	30	100	04
BT 552: Environmental Biotechnology	04	03	70	30	100	04
BT 553: Bioinformatics	04	03	70	30	100	04
BT 554: Biostatistics and Intellectual Property rights	04	03	70	30	100	04
Practical						
BT 555: Immunology, Environmental Biotechnology and Bioinformatics	08	04	70	30	100	04
Project						
BT 556: Project**	08		70	30	100	04
Seminar	01			25	25	01
Total			**420**	**205**	**625**	**25**
Grand total (I, II, III and IV Sem)					**2,500**	**100**

*Internal assessment (IA)

Theory: based on one test and one assignment for each paper

Practical: based on records and one test in each practical

**Project (BS 556): based on continuous assessment (15 marks) and one seminar (15 marks)

BT 401 BIOCHEMISTRY AND BIOPHYSICS Hours: 52

UNIT I (13 hrs)

Chemical bonds. Thermodynamic principles, free energy, enthalpy and entropy, chemical equilibrium, reaction kinetics, redox processes. ATP as an energy currency in the cell and other high energy compounds. Standard free energy, coupled reaction. pH and buffer concept. Carbohydrates – Stereochemistry, general reactions, classification, polysaccharides- structure, function - relation (e.g. Starch and cellulose). Carbohydrate metabolism: Glycolysis, inter conversion of various monosaccharides, pathway of citric acid cycle, anapleurotic reaction, gluconeogenesis and pentose phosphate pathway.

UNIT II (13 hrs)

Classification of amino acids, general reactions, titration curves, peptide bonds, conformational properties of polypeptides – Primary, secondary, tertiary and quaternary structures
Globular and fibrous proteins.
Protein structure – Myoglobin, silk fibroin, α-keratin, collagen, hemoglobin
Amino acids, deamination, transamination, transdeamination, decarboxylation, urea cycle, ketogenic and glucogenic amino acids. metabolism of aromatic amino acids, histidine, cysteine and serine.
Protein folding – Denaturation, effects of temperature and solvent on the thermodynamics of protein folding and unfolding equilibrium.
Biological functions of fat-soluble vitamin: A, D, E and K. Water soluble vitamins: coenzymes.

UNIT III (13 hrs)

Lipid classification, triacyl glycerol, phospholipids, sphingolipids, cholesterol and liposomes; prostaglandins, leukotrienes, thromboxanes, Plasma lipoproteins. Oxidation of fatty acids, α , β and ω types. Energetics of beta oxidation. Biosynthesis of fatty acids, cholesterol biosysnthesis, ketone body formation, interconversion of phospholipids.
Nucleic acid chemistry, bases, base-pairing rules, Watson-crick model of DNA, Properties of DNA-denaturation, renaturation, melting temperature, hyperchromicity, different structural forms of DNA. Different types of RNAs, general chemical reactions of RNA and DNA.

UNIT IV (13 hrs)

Spectroscopy – UV-visible, fluorescent spectroscopy, CD spectroscopy, NMR, X-ray diffraction, Mass spectroscopy. Radioisotope techniques – nature of radiation sources, radioactive decay, units of radiation, detection and measurements of radioactivity, autoradiography, GM counter, Scintillation counter. Principles of nanotechnology.

References

1. Basic concepts of analytical chemistry. S.N. Khopkar. New age Pub.
2. Bio-Chemistry. Lubert Stryer, Freeman & Co., New York
3. Biochemistry. Zubay, Mac Millan Pub.
4. Biophysical Chemistry: Principles and techniques. A. Upadhaya, Himalaya Pub.
5. Harpers review of Biochemistry. Martin et al., Large medical Pub.
6. Nuclear and Radio Chemistry. Gerhan Fried lander John Wiley and sons.
7 Principle of Biochemistry. A.L. Leninger, David L. Nelson and MM. Cox CBS Pub.
8. Principles of instrumental analysis. Da Skooge Holt - Saunders.
9. Text book of biochemistry with clinical correlation. TM Devlin. John Wiley and Sons.

BT 402 MICROBIOLOGY Hours: 52

UNIT I (13 hrs)

Historical perspectives, origin and evolution of microorganisms, principles of classifications, numerical and molecular taxonomy, Comparative morphology, structure and reproduction in archaebacteria, eubacteria, cyanobacteria, yeast and fungi

Microbial nutrition, nutritional grouping of microorganism; Growth kinetics, factors affecting growth and death; methods of isolation, enumeration, cultivation and preservation of microorganisms

UNIT II (13 hrs)

Microbial metabolism: Microbial respiration, aerobic and anaerobic respiration, fermentation, Bacterial photosynthesis. General account of symbiosis, mutualism, antagonism, parasitism and commensalism in microorganisms. Nucleic acid metabolism: Biosynthesis – *de novo* and salvage pathways, catabolism of purine and pyrimidine

UNIT III (13 hrs)

Classification, morphology, ultrastructure and life cycle of plant viruses, animal viruses and bacteriophages DNA viruses: Herpes virus, Adenovirus, WTV; RNA viruses: Polio, Influenza, Retroviruses (HIV); Bacteriophages: lambda phage, bacteriophage MU, M13, T3, T4

UNIT IV (13 hrs)

Plant microbe interactions: Rhizosphere, mycorrhizas, rhizobia, diazotrophs and endophytes

Plant pathogen interactions: *Phytophthora*, *Agrobacterium* and TMV

Animal microbe interactions: Tuberculosis, dermatophytes, Rabies, Mycoplasma and Rickettsiae, typhoid, leprosy, cholera; Antibiotics: types, mode of action and drug resistance (Cholera, *Salmonella* and *Staphylococcus*), antimicrobial therapy

Principles of microbial spoilage of food, Methods of food preservation by physical (freezing, canning, pasteurization and irradiation) and chemical (preservatives, lactic antagonism) methods

Microbial food poisoning (botulism, mycotoxins, algal toxins, cholera and salmonellasis)

References

1. Biology of microorganisms. Brock TB and Madigon. Prentice Hall.
2. Element of microbiology. Pelczar J. and Chan ECS. Mac Graw Hill New York.
3. General Microbiology. Schlegel HG, Cambridge Univ. Press.
4. Microbial biology. Rosenberg E and Cohen IR. Saunders Coll. Pub.
5. The microbial world. Stanier RY et al., Prentice Hall New Delhi.

BT 403 CELL BIOLOGY Hours: 52

Unit I (13 hrs)
Introduction; Prokaryotic and eukaryotic cells; Difference between plant and animal cells. Membrane structure: Different models of membrane structure - Lipid bilayer, membrane proteins, membrane carbohydrate, transport across biomembranes, Mechanisms of endocytosis and exocytosis, Ion channels, Electrical properties of membranes; Nerve impulse transmission. Chemical composition of cell walls, cross linkage, porosity, tensile strength, turgor modifications in special types of cells, plasmodesmata, fluid transport between cells.

Unit II (13 hrs)
Subcellular Organization: Ultrastructural organization and functions of Golgi complex, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, lysosomes, ribosomes, nucleus and nucleolus.

Unit III (13 hrs)
Structure, organization and types of eukaryotic chromosomes, Heterochromatin, euchromatin, teleomeres, types of chromosomes, polytene chromosomes and lampbrush chromosomes. Chromosome dynamics during cell division: Mitosis, meiosis, microtubules, centrosome, centromere, kinetochore, metaphase and anaphase movements, motor proteins, cytokinesis and cell cycle regulations.

Unit IV (13 hrs)
Cell signaling: Various types of cell signaling-endocrine, paracrine, juxtacrine and autocrine. Hormones and growth factors, Cellular responses to environmental signals in plants and animals; Receptors -mechanisms of signal transduction and second messengers.
Integrating cells into tissues**:** Cell adhesion, Cell junctions; Extracellular matrix, extracellular matrix receptors and signaling

References

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2. Cooper, Geoffrey M.The Cell. A Molecular Approach. Sunderland: Sinauer Associates, Inc.
3. De Robertis, E.D.P. and De Robertis, E. M.F. Cell and Molecular Biology. B.I. Waverly Pvt. Ltd., New Delhi.
4. Gilbert, Scott F. Developmental Biology. Sunderland (MA): Sinauer Associates, Inc.
5. Molecular cell Biology. Harvey Lodish, Arnold Berk, S. Lawence Zipursky, Paul Matsudaira & David Baltimore. WH. Freeman and company, New York.
6. Karp, G. Cell and Molecular Biology. Concepts and experiments. John Harris, D., Wiley & sons, New York.
7. Principles of Cell and Molecular Biology. Kleinsmith, L. J. & Kish, V.M.. McLaughlin, S., Trost, K., Mac Elree, E., Harper Collins Publishers, New York.

BT 404 MOLECULAR GENETICS Hours: 52

UNIT I (13 hrs)

Mendelian genetics, symbols and terminology, principle of segregation, principle of independent assortment, multiple alleles, interaction of genes, pleiotropy; Deviations and exceptions to Mendelian ratios – variation of dominance, multiple alleles, sex-linkage, linkage and crossing over and chromosome mapping. Sex determination, dosage compensation and extrachromosomal inheritance (e.g. *Chlamydomonas*, snail, *Neurospora* and yeast)

UNIT II (13 hrs)

Identification of DNA as genetic material, experiments of Griffith, Avery MacLeod and McCarthy. Molecular mutation (mechanisms of missense, nonsense, transition, transversion and frame-shift mutation, lethal mutation, origin of spontaneous mutation and control) Recombination in bacteria: Transformation, transduction and conjugation. DNA damage – mechanical and chemical; types of DNA repair, photo-reactivation, base excision, recombination, mismatch, SOS.

UNIT III (13 hrs)

C-value paradox, co-linearity of genes, split genes, gene families.
Study of model systems: *Drosophila*, *Arabidopsis* and human beings.
Human Cytogenetics: Human karyotype construction, Mendelian and chromosome based heritable diseases and syndromes (colour blindness, retinoblastoma, haemophilia, cystic fibrosis, sickle cell anaemia, Down's syndrome, Klinefelters's syndrome, Turner's syndrome, Edward's syndrome and Cri-du-chat syndrome), Prenatal diagnosis (amniocentesis and chorionic villus sampling). Genetic counseling.

UNIT IV (13 hrs)

Transposable elements, Discovery, types and their significance in bacteria and Eukaryotes
Population and evolutionary genetics: Genetic variation, Hardy-Weinberg equilibrium, inbreeding, outbreeding and changes in allelic frequency. Genetics and evolution

References

1. Basic Ggenetics. Hartl DL Jones and Bartlett Pub.
2. Genes. Lewin B., Oxford Univ. Press.
3. Mobile Genetic Elements. Shapilo NY., Academic press.
4. Microbial Genetics. Maloy SR. Friefelder, Jones and Bartlett Pub.
5. Molecular Biology of Gene. Watson JD et al., Benjamin Cumming Pub.
6. Molecular Genetics of Bacteria. JW Dale. John Wiley and sons.
7. Principle of Genetics – Gardner et al., John Wiley and sons Pub.

BT 405 BIOCHEMISTRY AND MICROBIOLOGY

Color reactions for mono-, di- and polysaccharides
Identification of unknown carbohydrates
Estimations of blood glucose, free fatty acids, cholesterol and proteins
Estimation of amino acids, serum proteins and blood urea
Determination of urine creatinine
Tests for non-protein nitrogen (NPN) substances
Determination of plant phenolics and ascorbic acid
Chromatography (TLC and Column)
Colorimetry
Flame photometry
Electrophoresis

Microscopic observations of microorganisms
Microbial staining techniques (simple and differential staining, cell wall, endospores, intracellular lipids, acid-fast, flagella, viability)
Microbial motility tests
Sterilization techniques
Microbial culture media and their preparation
Isolation techniques
Maintenance of microorganisms (stock culture and subculture)
Microbial characterization based on biochemical tests
Quantitative and quantitative assessment of microflora in soil, water, air and food
Milk microbiology
Studies on bacteria, fungi and actinomycetes
Studies on symbiotic association of microorganisms

BT 406 CELL BIOLOGY AND MOLECULAR GENETICS

Microscopy, micrometry, microtomy
Study of mitosis and meiosis in plants and animals
Preparation of mitotic chromosomes and karyotyping
Staining techniques: Staining blood cells, total count and differential count
Histology and differential staining (cellular organelles and components)
Brushborder membrane
Studies on nerve impulses
Separation of subcellular constituents
Isolation of RNA and DNA
Estimation of RNA and DNA

Morphological features of *Drosophila*
Mounting genital plate and sex comb in *Drosophila*
Isolation and staining of salivary gland chromosomes in *Drosophila*
Mutants of *Drosophila*
Micronucleus test in mice
Banding techniques and karyotyping
Demonstration of Barr bodies in buccal cells
Study of human blood groups
Chromatographic separation of eye pigments in *Drosophila*
Problems on quantitative inheritance
Problems on gene frequencies in population

BT 451 MOLECULAR BIOLOGY Hours: 52

Unit I (13 hrs)

Central Dogma of molecular biology. DNA Replication: Semiconservative mechanism, prokaryotic and eukaryotic DNA replication, Okzaki fragments; enzymology and control of DNA replication; inhibitors of replication; Replication in Øx 174, M-13, T-phages and Lambda phages.

Unit II (13 hrs)

Transcription: Prokaryotic and Eukaryotic Transcription.-RNA polymerase sub units, different sigma factors, initiation, elongation and termination - rho dependent and independent; antitermination, control by antisense RNA; attenuation and other influences of translational apparatus on the process of transcription, eukaryotic promoters, enhancers, transcription factors, various protein motifs involved in DNA protein interaction during transcription.

RNA processing enzymes, modification in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing; RNA Editing, Nuclear export of mRNA; mRNA stability. Different modes of mRNA, tRNA, and rRNA splicing, role of various snRNPs.

Unit III (13 hrs)

Translation in Prokaryotes and Eukaryotes: Genetic code, initiation of translation, chain elongation, Termination, post-translational modification and structure determination and involvement of different translational factors at different stages of the process. Folding of polypeptides; involvement of molecular chaperon, Protein splicing. Inhibitors of translation, translational control mechanism. Organization of prokaryotic and eukaryotic genomes. Regulation of gene expression in prokaryote and eukaryotes, operon concept, catabolic repression, repressible enzyme systems, control by attenuation, positive control, gene regulation in eukaryotes, transcriptional regulation, post-transcriptional regulation. Environmental regulation of gene expression.

Unit IV (13 hrs)

Carcinogenic agents and molecular biology of cancer: Abnormal cell growth: mechanism of transformation of cells. Genetic basis of Cancer, Physical and chemical carcinogenic agents; Viral and cellular oncogenes, tumor suppressor genes, Telomerases and their role in cancer.

Developmental Biology: Gene action during oogenesis, transcriptional role of oocyte lamp brush chromosomes, ribosomal RNA synthesis during oogenesis, spermatogenesis, Germ cells and fertilization, Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity. Egg activation, cleavage morphogenetic movements, Genetic basis of differentiation, molecular genetics of pattern formation - in *Drosophila*, *C. elegans*, *Xenopus* and mouse. Nuclear cytoplasmic interactions during development.

References

1. Molecular Biology of the Cell. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. Garland Publishing, Inc., New York.
2. The Cell - A Molecular Approach. Cooper, Geoffrey M. Sunderland: Sinauer Associates, Inc.
3. Cell and Molecular Biology. De Robertis, E.D.P. and De Robertis, E. M.F. B.I. Waverly Pvt. Ltd., New Delhi.
4. Developmental Biology. Gilbert, Scott F. Sinauer Associates, Inc.
5. Molecular cell Biology. Harvey Lodish, Arnold Berk, S. Lawence Zipursky, Paul Matsudaira & David Baltimore. WH. Freeman and company, New York
6. Cell and Molecular Biology – Concepts and experiments. Karp, G., John Harris, D., Wiley & sons, New York.
7. Principles of Cell and Molecular Biology. Kleinsmith, L. J. & Kish, V.M. McLaughlin, S., Trost, K., Mac Elree, E., Harper Collins Publishers, New York
8. Genes VII. Lewin, B. Oxford University Press

BT 452 GENETIC ENGINEERING Hours: 52

UNIT I (13 hrs)

Restriction – modification systems, Restriction enzymes – type I, II and III, specificity, sticky ends and blunt ends, isoschizomers. Double digests. DNA ligases, optimium ligation conditions. Enzymes to modify the terminals of DNA- Alkaline phosphatase, polynucleotide kinase, DNase I, S1 nuclease, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNase H and DNA topoisomerase. Use of linkers, adapters and homopolymer tailing. Other methods of joining DNA molecules: TA cloning of PCR products, Construction of genomic libraries, construction of cDNA libraries, methods of cDNA synthesis; PCR: Design, optimization, types and applications.

UNIT II (13 hrs)

Essential features of vectors for transforming bacteria and yeast, animals and plants
Special vectors: Shuttle vectors, expression vectors, Construction of Artificial chromosomes vectors BACs, YACs and MACs. Cosmids, phagemids and phasmids. Fusion vectors. Viral vectors. Techniques of introducing genes in Prokaryotes and eukaryotes: transformation, calcium phosphate method, DEAE- Dextran method, protoplast fusion/somatic cell hybridization. Liposome mediated transfer, microinjection, electroporation and gene gun.

UNIT III (13 hrs)

Identifying the right clones: Direct screening: Insertional inactivation of marker gene, visual screening, plaque phenotype. Indirect screening: Immunological techniques, Hybrid arrest translation, Hybrid select translation. Screening using probes: Construction of gene probes, hybridization and labeling. Nucleic acid hybridization – Southern blotting, colony hybridization, dot blo; Chromosome walking and chromosome jumping.
DNA sequencing: Maxim and Gilbert's method, Sanger and Coulson's method, Messing's shot gun method, Automated sequencers; Analysis of genetic variation: Single nucleotide polymorphism, conserved and variable domains, RFLP, AFLP, EST, STS, SCAR, SSCP. DNA finger printing. Genome sequencing: overview, strategies (e.g. Human genome project)

UNIT VII (13 hrs)

Mapping of DNA : Restriction mapping, DNA footprinting, mapping by somatic cell hybridization. Use of transposons in gene mapping
Analysis of gene expression: Analysis of transcription by Northern blot, RNase protection assay, Primer extension assay, in situ hybridization. Comparing transciptomes: Differential screening, subtractive hybridization, array based methods; Implication of Genetic engineering.
Methods of studying promoter, reporter genes, locating the promoter, regulatory elements and DNA-binding proteins. Translational analysis: Screening expression libraries with antibodies – Western Blot, two-dimensional electrophoresis. Manipulating gene expression: Transcriptional fusions, translational fusions, In vitro mutagenesis: Oligonucleotide directed mutagenesis, deletions, Insertional mutagenesis, direct single base mutagenesis.

References

1. From Genes to Clones, Winnaker. Panima Educational Book agency
2. Genes VII, Lewin, Oxford University Press.
3. Principles of Gene Manipulation. Old and Primrose- Blackwell scientific Pub.
4. Recombinant DNA Technology. Watson JD et al., Scientific American Book Series.

BT 453 ENZYMOLOGY Hours: 52

UNIT I (13 hrs)
Enzyme nomenclature and classification, isolation of enzymes, extraction of soluble and membrane bound enzymes, purification of enzyme- criteria for purification, assay of enzymes Structure and general properties of enzymes, active site and specificity of enzymes, Enzyme substrate complex, theories of enzyme catalysis, proximity and orientation, acid-base catalysis. Nucleophilic and electrophlic reaction of enzymes, factors affecting enzyme activity, temperature, pH, time substrate concentration.

UNIT II (13 hrs)
Isozymes, co-enzymes, metalloenzymes, multifunctional and multienzyme complexes, PDC Kinetics of enzyme catalysed reactions, free energy of enzyme reactions, presteady state, steady state kinetics, Michalis Menton equation for steady state and equilibrium state, Lineweavr-Burk, Eddie – Hofstee and Hanes plot, Cornish Bowden plot, fast kinetics to elucidate the intermediates and rate limiting steps. Multiple substrate reaction Types with specific examples (bisubstrate)

UNIT III (13 hrs)
Enzyme inhibitors – types of inhibitors, mechanism of enzyme inhibition, competitive, Non-competitive, uncompetitive and inhibition. Suicide inhibition, allosteric and irreversible inhibition – significance. Mixed kinetics of reversible inhibition, transition state analogs Allosteric enzymes and metabolic regulation, sigmoid kinetics, steady-state metabolic pathway, concerted and sequential models to explain the sigmoid nature of allosteric enzymes. Regulation of metabolic pathway by control of enzyme activity. Zymogen, substrate analogues and their uses.

UNIT IV (13 hrs)
Mechanism of action of lysozyme, chymotrypsin, aspartate transcarbamylase, Alcohol dehydrogenase, RNA as enzyme.
Synthetic enzymes, Ribozyme, Abzyme, clinical and industrial application of enzymes, enzymes and inborn errors of metabolism, enzymes as reagents in clinical chemistry, (Analytical tools) Enzyme engineering (Protein engineering), Immobilization of enzyme and their applications

Referencs

1. Enzyme Biochemistry, Biotechnology and Clinical Chemistry. Trevor, Harwood Pub.
2. Enzyme Technology. MF Chaplin and Bruke, Cambridge Univ. Press
3. Fundamentals of Enzymology. Nickolas CP Lewin Oxford Pub.
4. Immobilised Enzymes and Cells. A. Rosevear et al., IOP Pub.
5. Industrial Enzymes and their Applications. Helmut Uligh. John Wiley and sons
6. Thermostability of Enzymes. MN Gupta. Narosa Pub.

BT 454 BIOPROCESS TECHNOLOGY Hours: 52

UNIT I (13 hrs)

Basic principles in bioprocess, advantages of bioprocess over chemical process. Isolation and improvement of industrially important strains. Design of fermentation media, inoculum development.

Sterilization – Sterilization of medium, air and fermenters. Thermal death kinetics.

UNIT II (13 hrs)

Design of fermenter- criteria for ideal fermenter, aeration, agitation, valves, baffles, heat exchanges.Types of fermenters: The Waidhof-type fermenter, tower fermenter, cylindroconical vessels, air-lift fermenter, deep-jet fermenter, the cyclone column, the packed tower, rotating disc fermenter and photobioreactors. Animal cell culture fermenter-stirred fermenter, microcarrier, encapsulation, hollow fiber chambers, packed glass bead reactors. Cell immobilization techniques. Stability of microbial reactors.

UNIT III (13 hrs)

Types of fermentation processes: submerged fermentation, surface or solid substrate fermentation, batch fermentation, continuous fermentation, kinetics of fermentation processes Transport phenomenon in bioprocesses- mass transfer, Mass transfer co-efficient for gases and liquids, oxygen transfer co-efficient, biological heat transfer and heat transfer coefficients. Online acquisition: Bioprocess control and monitoring of variables such as temperature, agitation, pressure, pH, PID control, use of computers in bioprocess control systems (data logging, analysis and control).

UNIT IV (13hrs)

Downstream processing of biological molecules: Separation of cells, foam separation, flocculation, filtration, centrifugation (Basket and bowl centrifugation), cell lysis methods, physical and chemical methods. Large scale separation techniques like Distillation, solvent extraction, liquid-liquid extraction, chromatographic techniques, membrane filtration, ultra filtration, reverse osmosis, crystallization, spray drying, drum drying, freeze drying, whole broth processing. Application of cells in bioprocess (LAB, PAB, yeast, mixed cultures, plant and animal cells). Biosensors: construction and application, fermentation economics.

References

1. Biochemical Engineering fundamentals, Baily & Ollis McGram-Hill Pub.
2. Chemical Engineering. J.M Coulson Pregamon Press
2. Comprehensive Biotechnology. Volumes 1, 2, 3 & 4. Murray moo young Pergamon Press
3. Fundamentals of Biotechnology. P. Prave et al., WCH Weinhein Pub.
5. Principles of Fermentation Technology. P.F. Stanburry & Whitaker Pergamon Press

BT 455 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Autoradiography to study the structure of molecules
Induction of tumors and its prevention
Structure of sperms and eggs
Spermatogenesis (e.g. grass hoppers)
Chick and *Drosophila* developmental stages
Histological identification of germ layers of developing embryos
Induced breeding in fishes

Isolation of DNA and RNA from bacteria, plants and yeasts
Southern and Northern blotting techniques
Western blotting
Studies on DNA replication
Studies on vectors
Ti plasmid
Probes
Chromosome mapping
Sequencing
PCR techniques
Construction of DNA libraries
Genomics and Proteomics
Study of mutagenesis

BT 456 ENZYMOLOGY AND BIOPROCESS TECHNOLOGY

Extraction, isolation and prurification of soluble and membrane bound enzymes
Enzyme assays
Study of enzyme kinetics (effect of substrate concentration, pH, temperature and metal ions)
Determination of K_m and V_{max}
Mechanism of enzyme inhibition
Mechanism of action of lysozyme, chymotryptin polymerases
Immobilization of enzymes and their applications

Isolation of microbes of industrial importance
Instrumentation in bioprocess technology
Growth and death kinetics of microbial cultures
Cell encapsulation (immobilization) techniques and uses
Pilot-scale production of microbial (or plants or animal) cell products
Downstream processing techniques
Lyophilization
Biosensors

BT 501 PRINCIPLES OF BIOTECHNOLOGY (Choice-based paper) Hours: 52

UNIT I (13 hrs)

Principles of evolution of life. Evolutionary tree. Origin of microbes and higher organisms. Cell is a unit of life. Representative prokaryotic and eukaryotic cells (bacteria, plant and animal cells), higher organisms. Viruses. Nucleic acids (DNA, RNA) and proteins. Genes and genetics. Biodiversity: Microbial, plant and animal diversity; Hotspots of biodiversity; Biodiversity issues and concerns. Biotechnology: Facets and principles of biotechnology: Traditional and modern biotechnology.

UNIT II (13 hrs)

Growth and control of microorganisms (e.g. bacteria, fungi, yeasts). *Escherichia coli*. Beneficial and harmful microbes. Normal microflora associated with humans and animals. Microbes in human and animal nutrition (e.g. ruminants and non-ruminants) and health. Microbial biotechnology: Fermentation (e.g. ethanol, bread, milk, oriental foods, antibiotics, organic acids, enzymes, hormones, biogas, biofuels, amino acids, vitamins), high value low-volume biochemicals and fermenters for fermentation. Single cell proteins, mushrooms as food, probiotics and microbial gels. Genetic manipulation of microorganisms: Conventional and molecular approaches.

UNIT III (13 hrs)

Plant biotechnology: Mendalism, *Arabidopsis thaliana*. Genetic manipulation (GM) of plants, GM plants (e.g. BT cotton, BT brinjal, Golden rice, Flvr-savr tomato), GM foods. Plant tissue culture, synthetic seeds. Plant health and diseases. Plant-microbe associations, interactions (e.g. symbiosis, mutualism) and benefits. Plant cells to generate biochemicals and medicines. Micropropagation. Animal biotechnology: *Drosophila melanogaster*. Tool to study developmental biology. Transgenic animals (e.g. mice, sheep, fish). *In vitro* fertilization and (IVF) and embryo transfer (ET), test-tube babies. Animal cell culture and organ culture. Animal cells as source of biochemicals (e.g. vaccines, hormones). Animals as bioreactors (e.g. mice). Stem cells. Immunity, immunization and vaccines. Cancer and cancer therapy. Diagnosis of genetic diseases and gene therapy.

UNIT IV (13 hrs)

Environmental Biotechnology: Revegetation and energy plantations (e.g. Neem, *Jatropha, Pongamia*). Bioremediation (plant and microbial). Microbes in mining. Waste processing and utilization. Biodiversity vs. Biotechnology (tropical vs. temperate). Biotechnology and economics. GMOs and their release. Intellectual property rights related to life. Patent: Process, product and life. Biopiracy, GAAT and TRIPs. Litigations related to life (e.g. neem, Basmathi rice, turmeric). Traditional knowledge digital library. Ethical issues (e.g. human and animal rights, surrogate mother). Bioinformartics and futurology.

References

1. Biology of microorganisms. Brock TB and Madigon. Prentice Hall
2. Basic Biotechnology. Ratledge, C. and Kristiansen, B., Cambridge University Press
3. Microbial Ecology. Atlas and Bartha
4. Microbial Biotechnology. Alexander. G., WH Freeman and Company
5. Biotechnology of Higher Plants. Russell.
6. Plant Biotechnology. Mantell and Smith. Cambridge University Press
7. Animal Transgenesis and Cloning. Louis. Marie Houdebine, John Wiley & Sons.
8. Gene VII. B. Lewin. Oxford University Press, New York,
9. Environmental Biotechnology. Jogdanand, Himalaya Publishing House, New Delhi

BT 502 MICROBIAL BIOTECHNOLOGY Hours: 52

UNIT I (13 hrs)

Microbial products: Microbial Biomass, Primary metabolites, secondary metabolites microbial enzymes, transformed products. Gene cloning in microorganisms other than *E. coli* (*Salmonella, Rhizobium, Agrobacterium, Bacillus subtilis, Streptomycetes, Aspergillus niger*)

Microbial primary and secondary metabolites: Amioacids (Glutamic acid, L-lysine), Vitamins and hormones (vitamin B12, vitamin A, riboflavin, gibberellins). Organic acids and other industrial chemicals (Lactic acid, citric acid, alcohol, glycerol, acetone). Antibiotics (Penicillin, streptomycin, tetracycline), peptide antibiotics (lantibiotics)

UNIT II (13 hrs)

Microbial Enzymes: Microbial production of enzymes (Protease, amylase, invertase, pectinase, xylanase) substrate, production, purification of enzymes, immobilization, their application in food and other industries.

Microbial exopolysaccharides (EPS), classification and applications (health, industrial, pharmaceutical and food): Alginate, Cellulose, Hyaluronic acid, Xanthan, Dextron, Gellan, Pullulan, Curdlan, polysaccharides of lactic acid bacteria; Chitin, chitosan and chitin derivatives

UNIT III (13hrs)

Microbial beverages and food: Production of wine, beer, and vinegar

Microbial food: Oriental foods, Baker's yeast, cheese, SCP, SCO (PUFA), mushroom cultivation, sauerkraut, silage, probiotics. Nutraceuticals.

bioconservation, biofuels, gasohol, biogas; waste utilization to generate biofuels

UNIT IV (13 hrs)

Biofertilizers: *Rhizobium, Azotobacter, Azospirillum,* Cyanobacteria, *Mycorrhizas,* phosphate solubilizers, *Frankia*

Biopesticides: *Bacillus thuringiensis, Bacillus popillae, Trichoderma,* Baculoviruses,

References

1. Comprehensive Biotechnology. Volumes 1, 2, 3 & 4. Murray moo young, Pergamon Press
2. Fundamentals of Biotechnology. P. Prave et al., WCH Weinhein Pub.
3. Industrial Microbiology. Cassida
4. Industrial Biotechnology. Cruger & Cruge
5. Industrial Biotechnology. Arnold and Demain
6. Microbial Biotechnology. Alexander, G, WH Freeman and Company
7. Microbial Technology. Peppler, Volumes 1 & 2.

BT 503 ANIMAL BIOTECHNOLOGY Hours: 52

Unit I (13 hrs)

Animal tissue culture, history, laboratory design, aseptic conditions, methodology and media; Balanced salt solution and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Serum & protein free defined media and their applications; Equipments and materials for animal cell culture technology.

Basic techniques of mammalian cell culture *in vitro*; desegregation of tissue and primary culture; maintenance of cell culture; Cell lines-characteristics and routine maintenance. Measurement of viability and cytotoxicity. Cell separation techniques.

Unit II (13 hrs)

Biology and characterization of the cultured cells, measuring parameters of growth. Cell synchronization, Somatic cell fusion, Cell cloning

Organ and histotypic cultures. Three dimensional culture - Tissue engineering

Application of animal cell culture- Stem cell cultures, embryonic stem cells and their applications. Cell culture based vaccines.

Culture of Fish, mollusk and crustacean cells and its applications: Culture of secretary/glandular cells to produce hormones Pearl oyster mantle cells to produce pearls

Unit III (13 hrs)

In vitro fertilization (IVF) and embryo transfer (ET), Sex determination or sex specific markers, sexing of sperm and embryos, Assisted reproductive technology (ART). *In vitro* gamete maturation, Intracytoplasmic sperm injection, Cryopreservation of gametes and embryo, Animal cloning-reproductive cloning, therapeutic cloning, xenotransplantation

Animal genes and their regulation, some specific promoters for tissue specific expression. Gene manipulation in animals-cloning vectors and expression vectors for gene transfer to animal cells. Gene transfer methods in animal cells, Animal cells as cloning hosts. Gene expression in cell culture.

Unit IV (13 hrs)

Improvements of animals using transgenic approach with specific examples, animals as bioreactors: Applications of biotechnology in sericulture.

Production of Transgenic fishes. General steps to make and analyze transgenic fish and Genetically Improved Farmed Tilapia (GIFT).

Genetic engineering for production of regulatory proteins, blood products, vaccines and hormones. Applications of recombinant DNA in humans: mapping and cloning human disease genes, DNA based diagnosis of genetic diseases, gene therapy, types of gene therapy, somatic versus germline gene therapy, mechanism of gene therapy, Immunotherapy, gene knockout.

References

1. Animal Transgenesis and Cloning. Louis-Marie Houdebine John Wiley & Sons
2. Animal Cell Culture and Technology. Michael Butler BIOS Scientific Publishers
3. Animal Cloning: The Science of Nuclear Transfer (The New Biology). Joseph Panno
4. At the Bench: A Laboratory Navigator. Kathy Barker.
5. Basic Cell Culture: A Practical Approach. J.M. Davis, Oxford University Press, oxford.
6. Culture of Animal Cells: A Manual of Basic Technique. R. Ian Freshney Wiley-Liss.
7. Gene VII. B. Lewin. Oxford University Press, New York
8. Gene Biotechnology. William Wu et al., CRC Press
9. Molecular Biotechnology, ASM Press, Washington, B.R. Glick & J.J. Pasternak.
10. Principles of Gene Manipulation. Sandy B. et al., Blackwell Publishers
11. Principles of Cloning. Jose B. Cibelli et al., Academic Press
12. Recombinant DNA Technology. Scientific Americans Books, New York
13. Studies in Biotechnology Series # 7: Fish Biotechnology. MM. Ranga & Q.J. Shamni Agrobios, New Delhi

BT 504 PLANT BIOTECHNOLOGY Hours: 52

UNIT I (13 hrs)

Plant genome structure, gene families in plants, organization of chloroplast genome, mitochondrial genome and their interaction with nuclear genome, RNA editing in plant mitochondria. Mitochondrial DNA and Cytoplasmic male sterility. Plant breeding mechanism: types and applications

Biological oxidation: Electron transport chain, chemiosmotic hypothesis, ATP synthesis, oxidative phosphorylation, substrate level phosphorylation, uncouplers and inhibiters of respiration. Photosynthesis, regulation, Calvin cycle, C3-C4 plants

UNIT II (13 hrs)

Regulation of gene expression in plant development: Germination, apical meristem, floral development, leaf development, seed development and seed storage proteins. Plant hormones (auxins, cytokinins and gibberellins, IBA, NAA, 2-4-D, TD2) and phytochromes

Plant tissue culture, history, laboratory design, aseptic conditions, methodology, media, techniques of callus cultures, meristem cultures, anther culture, embryo culture, micropropagation, protoplast culture, somaclonal variation, synthetic seeds; Methods of plant tissue preservation and applications (cryopreservation)

UNIT III (13 hrs)

Cell suspension cultures and bioreactor technology, secondary metabolites, plant biosynthesis of alkaloids, flavonoids, terepenes, phenols: production, regulation and commercial importance. Plant-derived vaccines, plantibodies and pharmacognosy.

Gene rearrangement and nitrogen fixation in cyanophytes; Process of Nitrogen fixation in legumes by *Rhizobium*, cyanobacteria and actinomycetes, *nif* and *nod* genes. Biotechnological diagnosis of plant diseases

UNIT IV (13 hrs)

Development of transgenic plants for virus, bacteria, fungi, insect resistance. Transgenic crops for improved quality (BT cotton, BT brinjal, golden rice), herbicide tolerant, stress resistant plants, delayed fruit ripening, terminator seed technology, GM foods and human health.

References

1. Biotechnology in Agriculture and Forestry. Bajaj YPS, Springer Verlag Pub.
2. Biotechnology of Higher Plants. Russell.
3. Plant Cell and Tissue Culture. A Lab manual. Reinert J., Narosa Pub.
4. Plant Biotechnology. Mantell and Smith. Cambridge University Press
5. Plant Biotechnology. HS Chawla

BT 505 MICROBIAL BIOTECHNOLOGY AND METABOLISM

Proximate analysis of foods and feeds (moisture, nitrogen, crude fiber, crude lipids and ash)
Anaysis of antinutritional factors (e.g. phenolics, tannins, DOPA, trypsin inhibitors)
Calculation of calorific value
Mineral analysis of foods and feeds
Vitamin assay (water soluble and fat soluble)
Production and quantification of organic acids (e.g. citric acid, lactic acid, butyric acid)
Catabolism of purine and pyrimidine
Fatty acid oxidation
Experiments on photosynthesis (C3 and C4 plants)
Estimation of secondary metabolites (e.g. alkaloids, antibiotics)

Submerged and solidstate fermentation
Estimation of microbial biomass
Estimation of microbial enzymes, mycotoxins, organic acids and antibiotics
Microbiological assays (antibiotics, amino acids and vitamins)
Properties of microbial exopolysaccharides (e.g. cell immobilization)
Uses of Chitin and its derivatives
Pilot scale production of alcoholic beverages
Microbial interactions with plants (rhizobia, mycorrhizas) and plant production
Assessment of nitrogen fixation (acetylene reduction test)
Phosphate solubilization in bacteria, fungi and actinomycetes
Qualities of biofuels (e.g. biodiesel, biogas)

BT 506 ANIMAL AND PLANT BIOTECHNOLOGY

Cleaning and sterilization methods for tissue culture
Preparation of media, buffers
Maintenance of cultures (normal and tumor cell lines)
Separation of peripheral blood mononuclear cells
Cell counting (hemocytometer)
Lymphocyte culture technique
In vitro macrophage culture from mouse
Preparation of human metaphase chromosomes
Cell viability tests
Cell proliferation assay
Growth kinetics of cells in culture
In vitro fertilization and embryo transfer techniques
Cryopreservation techniques
Cytotoxicity tests

Estimation of plant hormones (e.g. auxins, gibberellins)
Plant tissue culture methods
Callus culture (compact and friable)
Ovule and anther culture
Cell suspension cultures
Embryogenesis
Synthetic seeds
Protoplast preparation
Protoplast fusion techniques
Plant cell immobilization
Methods of inducing resistance through tissue culture

BT 551 IMMUNOLOGY Hours: 52

UNIT I (13 hrs)

History and scope of immunology. Types of immunity – humoral and cell mediated. Innate and adaptive immunity. Specificity and memory. Primary and secondary lymphoid organs; immunization.

Cells involved in immune response-T-cells, B-cells. Clonal selection theory. Lymphocyte activation, clonal proliferation, differentiation. Effector mechanisms in immunity-macrophage activation. Lymphokines – Interleukins and their role in immune regulation. Toxin and Toxin resistance.

UNIT II (13 hrs)

Antigens and haptens, determinants; types of immunoglobulins: structure, distribution and function. Antigen-antibody reactions – Antigen equilibrium, dialysis, precipitation reactions, immunodiffusion. Affinity and Avidity. Immunization and antibody response. Antibody diversity - V, D, J, gene segments and DNA rearrangements, molecular biology of antibody synthesis. Complement system.

UNIT III (13 hrs)

Human and mouse, MHC, Transplantation immunology. HLA in human health and disease HLA tissue typing. Immune-suppression in transplantation. Hypersensitivity reaction, treatment approaches. Immunological tolerance.

Autoimmune diseases. Thyrotoxicosis, Systemic Lupus Erythromatosis, Antinuclear antibodies. Tumor immunology – tumor antigens, immuno-surveillance, immunological escape. Immune deficiency diseases – AIDS; Immunological tolerance.

UNIT IV (13 hrs)

Production, purification and characterization of monoclonal antibodies. Polyclonal antibodies versus monoclonal antibodies. T-cell cloning and their applications. ELISA, RIA, Western blotting, Fluorescent techniques, Fluorescent activated cell sorter (FACS). Concepts in vaccine development. Types of vaccines. Immunotherapeutic approaches to disease treatment-immunotoxins, Lymphokine- activated killer cells.

References

1. Cellular and Molecular Immunology. Abul K. Abba, Andrew H. Lichtman, Jordan S. Pober, Saunders Co.
2. Essential Immunology. Ivan Riott, Blackwell Publishers
3. Handbook of Experiments in Immunology, Vol. 1 & 2, Wier DM, Blackwell scientific Pub.
4. Immunology. Janis Kuby. Freeman and Co.
5. Immunology. Ivan Riott, Jonathan Brostoff and David Male. Mosby publishers
6. Immunobiology. Janeway and Travers. Churchill Livingstone Pub.
7. Practical Immunology. Hudson et al., Blackwell Scientific Pub.

BT 552 ENVIRONMENTAL BIOTECHNOLOGY Hours: 52

UNIT I (13 hrs)

Biogeochemical Cycles: Carbon, nitrogen, oxygen, phosphorous, sulphur, iron and calcium; cycling of toxic metals (Cd, Hg, Pb). Environmental pollution: Soil (ecotoxicology of pollutants; fate of insecticides, fungicides and pesticides in soil; physicochemical and microbiological analysis), water and air pollution monitoring (e.g. SO_2 and NO_x); Pollution indicator organisms (plants, animals and microbes) (e.g. algae, Chironomids, coliforms, *Salmonella, Shigella, Vibrio*, Hepatitis A).

UNIT II (13 hrs)

Microbial degradation of toxic chemicals (pesticides, detergents, plastics). Degradation of organic compounds (cellulose, lignin, hydrocarbons: aliphatic, aromatic, allicyclic hydrocarbons). Microbial deterioration of textiles, paper, leather, wood.

Biomaterials, microbial mining (uranium, copper, gold, iron), microbial influenced corrosion and remedies, bioaccumulation, biomagnification, biogas production as non-conventional energy sources

UNIT III (13 hrs)

Principles of microbial bioremediation, *in situ* and *ex situ* bioremediation, microbiological treatment of solid wastes – composting, land farming, bioreactors. Biological treatment of liquid wastes – aerobic and anaerobic treatments sewage and effluent treatments.

Pollution control measures, international and national pollution regulatory acts; Permissible limits and indices for pollutants; Hazardous wastes: microbial processing and disposal (radioactive wastes, sewage, pharmaceuticals, refinery and leather). Waster management and utilization (plantation crop wastes, aquatic weeds, kitchen/garden waste, poultry waste).

UNIT IV (13 hrs)

Natural products (wood, rubber, coir and gums). Food processing (dairy, bakery, beverages, vegetable and cashew).

Coastal regulatory zone (CRZ) and environmental issues of aquaculture; biofouling (microfouling and macrofouling); biofilms; biomolecules from the sea; scope of marine biotechnology.

GMOs, Environmental release and monitoring of GMOs, Ethical issues

References

10. Ecology. Odum
11. Environmental Biotechnology. Jogdanand , Himalaya Pub. House
12. Environmental and Biochemistry. Kudesia & Jetley, Pragathi Prakashan Pub.
13. Microbial Ecology. Atlas and Bartha
14. Microbial Biotechnology. Alexander, G., WH Freeman and Com.
15. Sewage and Industrial Effluent Treatment. John Arundel, Blackwell Sscience Pub.
16. Soil Microbiology. N.S. Subba Rao, Oxford & IBH Pub.
17. Waste Water Engineering. Metcalf & Eddy, McGraw-Hill International

BT 553 BIOINFORMATICS Hours: 52

UNIT I (13 hrs)
Introduction to Bioinformatics. Computer fundamentals, Networking and Hardware fundamentals, Internet, World Wide Web, Web authoring. Unix operating system, PERL programming

UNIT II (13 hrs)
Biological databases – online databases and tools for bioinformatics, The nucleotide and protein sequence databases, primary and secondary databases, format Vs content, file formats for sequence databases, Structural databases, Protein Data Bank, Molecular Modeling Database at NCBI, Structure file formats, visualizing structural information, Molecular visualization software. Major web resources for bioinformatics
Phylogenetics - Introduction, tree definitions, optimality criteria, distance matrix methods and parsimony, Bootstrapping. Multiple sequence alignments – Progressive Alignment Methods, tree alignments, star alignments, patterns in pair-wise alignments, Profiles, Motifs, Prints, Domains, Hidden Markov Models and Blocks, Definition of protein families, sequence Vs family comparison, Stand alone packages: Phylip, Clustal

UNIT III (13 hrs)
Sequence Analysis - Introduction, the evolutionary basis of sequence alignment, the modular nature of proteins, Dynamic programming methods, Global and Local Alignments, Substitution scores and Gap penalties, Statistical significance of Alignments, Heuristic methods, database similarity searching, FASTA, BLAST, Low-Complexity Regions, Repetitive Elements, Stand alone packages for sequence analysis, GCG Wisconsin/Emboss packages. Detection of functional sites of DNA sequences (Promoter Scan and Gen Scan), gene structure prediction (e.g. CENSOR and Reapet Masker).

UNIT IV (13 hrs)
Predictive Methods for Nucleotides – tools and methods, prediction of genes and protein coding regions, conserved sequence pattern discovery, Whole genome analysis. Predictive Methods for Proteins – structure prediction methods. prediction of trans-membrane regions, Molecular modeling, online modeling servers (e.g. SWISSMOD). Genome sequencing strategies, Restriction mapping and Primer design
Microarray techniques, Gene Expression analysis, Protein Folding, Lattice models, Comparative modeling, threading, folds and function, Distributed Computing approach, genome@home, folding@home, proteomics, protein structure based targeted drug design – small molecular interactions and docking

References

1. Beginning Perl for Bioinformatics. James D. Tisdall
2. Bioinformatics: Sequence and Genome Analysis. David W. Mount
3. Bioinformtics: Methods and protocols. Stephen A. Krawetz, Humana Press
4. Fundamental Concepts of Bioinformatics. Krane & Raymer, Pearson Ed.
5. Introduction to Protein Structure. C.I. Branden and J. Tooze, Garland Pub.
6. Introduction to Bioinformatics. Attwood & Parrysmith, Pearson Ed.

BT 554 BIOSTATISTICS AND INTELLECTUAL PROPERTY RIGHTS Hours: 52

UNIT I (13 hrs)

Statistics – Definition, Application of statistics in Bioscience, Classification and tabulation, Graphical representation of data, Histogram, frequency polygon, frequency curve
Exponentials: Exponential growth; Logarithm: Logarithmic growth
Measures of central tendency, Measures of dispersion

UNIT II (13 hrs)

Normal distribution, Binomial, Poisson, Probability, non-parametric statistics, Correlation and regression; Sign test, Rank sum test, Rank correlation. Testing of hypothesis: Significance of t-test and ANOVA. Chi-square test of independence of attributes, chi- square test of goodness of fit. Design of experiments. Analysis of completely randomized, design, randomized block design. Diversity measures and evenness (e.g. Simpson and Shannon). Statistical packages (e.g. SYSTAT, StatSoft and SPSS).

UNIT III (13 hrs)

Biosafety and research: General guidelines for recombinant DNA research activity Containment facilities and biosafety practices; Biological warfare and Bioterrorism Intellectual property rights (IPR) (meaning, classification and forms), importance of IPR in Science and Technology. Patents, patenting procedures, patent applications and patenting laws; Biopiracy. Patent-related litigations and controversies (neem, Basmathi rice, turmeric and coffee). Salient features of Indian Patent Law.

UNIT IV (13 hrs)

CBD, GAAT, TRIPs, traditional knowledge and traditional knowledge digital library (TKDL). Plant variety protection, International Union for the Protection of new Varieties of Plants (UPOV), plant protection act, registration of new verities, rights and obligations, farmer's rights; traditional ecological knowledge.
Plant germplasm conservation, characterization and documentation. Seed certification (laws, regulations and standards), seed patent law.

References

1. Biostatistical Analysis. Zar J. H. Prentice Hall, New Jersey
2. Biostatistics. Alvin E.Lewis. East West, New Delhi
3. Biotechnology, Biosafety and Biodiversity. Sivamiah Shantharam, Jane F. Montegomery. Oxford & IBH Pub., New Delhi
4. Biotechnology. Rehm and G. Reed, VCH, New York
5. Biotechnology and Law – IPR Vol.1 & 2. Iver P.Cooper, Clark Boardman Callaghan.
6. Introductory Statistics for Biology. Edward Arnold. London
7. Statistics for Biological Sciences. William C. Shefler. Addison Wesley, California

BT 555 IMMUNOLOGY, ENVIRONMENTAL BIOTECHNOLOGY AND BIOINFORMATICS

Study of immune system in rats
Blood film preparation and study of immune cells
Histology of organs of immune system
Study of insect hemocytes
Production of antiserum
Isolation of lymphocytes
Antigen-antigen reactions (*in vitro*)
Phagocytosis (*in vitro*)
Immunodot technique
Immunodiffusion technique
Immunological diagnosis of pregnancy and infection
Demonstration of ELISA technique

Production of compost (methods)
Vermicompost and its analysis
Cultivation of mushrooms
Biogas (biofuels) production
Wastewater treatment methods
Solid waste treatment methods
Experiments on biofouling and biofilms
Experiments on industrial waste treatment methods (e.g. distillery, whey)

Introduction to bioinformatics
Biological databases
Use of databases (e.g. BLAST, FASTA)
Restriction mapping
Micro array techniques

BT 556: Project

Model Question Paper (Theory)

BIOTECHNOLOGY
PAPER NUMBER AND TITLE

Time: 3 Hours Max. Marks: 70

I Write short notes on **any FIVE** of the following (in 250 words): 5×3=15

Question No. 1: a-h (two questions from each unit)

II Write explanatory notes **any FIVE** of the following (in 500 words): 5×5=25

Questions No. 2 to 9 (two questions from each unit)

III Answer **any THREE** of the following (essay type answers): 3×10=30

Question No. 10 to 14 (at least on question from each unit)

Model Question Paper (Practical)

BIOTECHNOLOGY
PAPER NUMBER AND TITLE

Time: 4 Hours Max. Marks: 70

Questions consist of procedure and protocol, major and minor experiments, spotters, demonstrations, discussion, charts and class records